

The McGraw-Hill Dictionary of Scientific and Technical Terms (Fifth Edition) defines distribution in the statistical context (our context) as:

For a discrete random variable, a function (or table) which assigns to each possible value of the random variable the probability that this value will occur.

The fact that two particular measurements on different probes overlap says absolutely nothing about the characteristics of their *distributions*.

There is not the slightest suggestion in Chen et al. that any derived data *distributions* might overlap, that deconvolving overlapping portions should be performed, or that it would be of any benefit. The fact that two samples might overlap has absolutely no significance in this regard.

Furthermore, referring to pages 369-370 of Chen, it is clear that all of the samples are assumed to have the same probability distribution. There is not the slightest suggestion that samples might, from two distributions which need to be deconvolved.

In addition, convolution is not simply overlapping. For the Examiner's information, the undersigned is providing a copy of an internet page in which convolution is defined. Specifically, convolution is an operation which is performed between two *functions* and it produces a third function. This third function represents the overlap between the first function and the reverse, translated version of the second function. The definition provided notes that a convolution is a "kind of very general moving average." So, the invention deconvolves a moving average of an overlapping portion of two distributions.

Thus, knowing that two samples overlap tells us nothing about their probability distributions (functions), tells us nothing about whether the samples have probability distributions which are convolved, and certainly does not provide the slightest suggestion that the deconvolution operation be performed on the joint distribution of two variables to achieve anything of value.

It is respectfully requested that the Examiner give careful consideration to the preceding discussion. If he intends to persist in this rejection, it is requested that he specifically point out where in Chen there is the slightest suggestion of *distributions* needing to be convolved.

With all respect, the undersigned is trying to avoid the need to prepare and file an Appeal Brief, only to have the Examiner withdraw the rejection at that time.

Applicant's attorney has made every effort to demonstrate that this patent application is in condition for allowance. It is therefore earnestly requested that the application, as a whole, receive favorable reconsideration and that all of the claims be allowed as presently constituted. Should there remain any unanswered questions, the examiner is requested to call the applicant's undersigned attorney at the telephone number given below.

Dated: October 22, 2004

Respectfully submitted,

By

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McGraw-Hill Dictionary of Scientific and Technical Terms

Fifth Edition

Sybil P. Parker

Editor in Chief

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ress calls, generally by international agreement; for ships at sea and aircraft over the sea, it is 500 kilohertz. { də'stres, frē-kwən-sē }

distress signal [COMMUN] An international signal used when a ship, aircraft, or other vehicle is threatened by grave and imminent danger and requests immediate assistance; examples are special radiotelegraph and radiotelephone signals or special signal flags or flares. { də'stres, signəl }

distributary [HYD] An irregular branch flowing out from a main stream and not returning to it, as in a delta. Also known as distributary channel. { də'strib-yə, terē }

distributary channel See distributary. { də'strib-yə, terē, chan-əl }

distributed amplifier [ELECTR] A wide-band amplifier in which tubes are distributed along artificial delay lines made up of coils acting with the input and output capacitances of the tubes. { di'strib-yəd-əd 'amplə, frēr }

distributed capacitance [ELEC] Capacitance that exists between the turns in a coil or choke, or between adjacent conductors or circuits, as distinguished from the capacitance concentrated in a capacitor. { di'strib-yəd-əd kə'pas-əd-əns }

distributed circuit [ELECTR] A film circuit whose effective components cannot be easily recognized as discrete. { di'strib-yəd-əd 'sərket }

distributed collector [ENG] A component of a solar heating system comprising a series of modular focusing collectors that are interconnected with an absorber pipe network to carry the working fluid to a heat exchanger. { di'strib-yəd-əd kə'lek-tər }

distributed communications [COMMUN] Information transfer beyond the local level that may involve the originating source to transmit information to all communications centers on any one network, and may also cause an interchange of communications among several whole networks. { di'strib-yəd-əd kə'myū-nə'kā-shənz }

distributed constant [ELECTROMAG] A circuit parameter that exists along the entire length of a transmission line. Also known as distributed parameter. { di'strib-yəd-əd 'kän-stənt }

distributed control system [CONT SYS] A collection of modules, each with its own specific function, interconnected tightly to carry out an integrated data acquisition and control application. { di'strib-yəd-əd kən'tröl, sis-təm }

distributed database [COMPUT SCI] A database maintained in physically separated locations and supported by a computer network so that it is possible to access all parts of the database from various points in the network. { di'strib-yəd-əd 'dād-ə-bās }

distributed-emission photodiode [ELECTR] A broad-band photodiode proposed for detection of modulated laser beams at millimeter wavelengths; incident light falls on a photocathode strip that generates a traveling wave of photocurrent having the same wave velocity as the transmission line which the photodiode feeds. { di'strib-yəd-əd ə'mish-ən, fōd-ō, dī-ōd }

distributed fault See fault zone. { di'strib-yəd-əd, fōlt }

distributed free space [COMPUT SCI] Empty spaces in a data layout to allow new data to be inserted at a future time. { di'strib-yəd-əd 'frē 'spās }

distributed inductance [ELECTROMAG] The inductance that exists along the entire length of a conductor, as distinguished from inductance concentrated in a coil. { di'strib-yəd-əd in'dak-təns }

distributed intelligence [COMPUT SCI] The existence of processing capability in terminals and other peripheral devices of a computer system. Also known as distributed logic. { di'strib-yəd-əd in'tel-ə-jəns }

distributed logic See distributed intelligence. { di'strib-yəd-əd 'lāj-ik }

distributed logic cluster word processor [COMPUT SCI] A system of word processors each of which can operate independently, although printers are generally shared by a number of terminals. { di'strib-yəd-əd 'lāj-ik, kləs-tər 'wərd, präs, es-ər }

distributed network [COMMUN] A communications network in which there exist alternative routings between the various nodes. [COMPUT SCI] A computer network in which at least some of the processing is done at individual work stations and information is shared by and often stored at the work stations. { di'strib-yəd-əd 'net, wərk }

distributed numerical control [CONT SYS] The use of central computers to distribute part-classification data to machine tools

which themselves are controlled by computers or numerical control tapes. { di'strib-yəd-əd nü'mer-ə-kəl kən'tröl }

distributed parameter See distributed constant. { di'strib-yəd-əd pə'rām-əd-ər }

distributed-parameter system See distributed system. { di'strib-yəd-əd pə'rām-əd-ər, sis-təm }

distributed paramp [ELECTR] Paramagnetic amplifier that consists essentially of a transmission line shunted by uniformly spaced, identical varactors; the applied pumping wave excites the varactors in sequence to give the desired traveling-wave effect. { di'strib-yəd-əd 'par'amp }

distributed processing system [COMPUT SCI] An information processing system consisting of two or more programmable devices, connected so that information can be exchanged. { di'strib-yəd-əd 'präs, es-ən, sis-təm }

distributed system [SYS ENG] A system whose behavior is governed by partial differential equations, and not merely ordinary differential equations. Also known as distributed-parameter system. { di'strib-yəd-əd 'sis-təm }

distributing frame [ELECTR] Structure for terminating permanent wires of a central office, private branch exchange, or private exchange, and for permitting the easy change of connections between them by means of cross-connecting wires. { di'strib-yəd-ən, frām }

distributing point [ORD] Point at which supplies, obtained from the supply point by a division or other unit, are broken down for immediate distribution to subordinate units. { di'strib-yəd-ən, pōint }

distributing roller [GRAPHICS] A rubber-covered roller whose function is to deliver ink from the supply reservoir to the ink drum of the printing press. { di'strib-yəd-ən, rōl-ər }

distributing terminal assembly [ELECTR] Frame situated between each pair of selector bays to provide terminal facilities for the selector bank wiring and facilities for cross-connection to trunks running to succeeding switches. { di'strib-yəd-ən 'term-ən-əl ə,sem-blē }

distribution [IND ENG] All activities that involve efficient movement of finished products from the end of the production line to the consumer. [MATH] An abstract object which generalizes the idea of function; used in applied mathematics, quantum theory, and probability theory; the delta function is an example. Also known as generalized function. [STAT] For a discrete random variable, a function (or table) which assigns to each possible value of the random variable the probability that this value will occur; for a continuous random variable x , the monotone nondecreasing function which assigns to each real r the probability that x is less than or equal to r . Also known as distribution function; probability distribution; statistical distribution. { di's-trə'byū-shən }

distribution amplifier [ELECTR] A radio-frequency power amplifier used to feed television or radio signals to a number of receivers, as in an apartment house or a hotel. [ENG ACOUS] An audio-frequency power amplifier used to feed a speech or music distribution system and having sufficiently low output impedance so changes in load do not appreciably affect the output voltage. { di's-trə'byū-shən 'amplə, frēr }

distribution box [CIV ENG] In sanitary engineering, a box in which the flow of effluent from a septic tank is distributed equally into the lines that lead to the absorption field. { di's-trə'byū-shən 'bāks }

distribution cable [ELEC] Cable extending from a feeder cable into a specific area for the purpose of providing service to that area. { di's-trə'byū-shən, kā-bəl }

distribution center [ELEC] In an alternating-current power system, the point at which control and routing equipment is installed. { di's-trə'byū-shən, sen-tər }

distribution coefficient [OPTICS] One of the tristimulus values of monochromatic radiations having equal power, usually denoted by x, y, z . [PHYS CHEM] The ratio of the amounts of solute dissolved in two immiscible liquids at equilibrium. { di's-trə'byū-shən, kō-i'fish-ənt }

distribution control See linearity control. { di's-trə'byū-shən kən'tröl }

distribution curve [STAT] The graph of the distribution function of a random variable. { di's-trə'byū-shən 'kərv }

distribution deck [COMPUT SCI] A card file which duplicates all or part of a master card file and used for disseminating or decentralizing. { di's-trə'byū-shən, dek }

distribution factor [NUCLEO] A term used to express the



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Convolution

In [mathematics](#) and in particular, [functional analysis](#), **convolution** is a mathematical [operator](#) which takes two [functions](#) f and g and produces a third function that in a sense represents the amount of overlap between f and a reversed and translated version of g . A convolution is a kind of very general **moving average**, as one can see by taking one of the functions to be an [indicator function](#) of an [interval](#).

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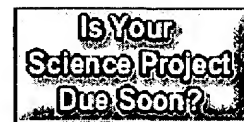
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Uses

Convolution and related operations are found in many applications of engineering and mathematics.

- In statistics, as noted above, a weighted moving average is a convolution.
- In statistics, the probability distribution of the sum of two random variables is the convolution of each of their distributions.
- In optics, many kinds of "blur" are described by convolutions. A shadow (e.g. the shadow on the table when you hold your hand between the table and a light source) is the convolution of the shape of the light source that is casting the shadow and the object whose shadow is being cast. An out-of-focus photograph is the convolution of the sharp image with the blur circle formed by the iris diaphragm.
- In acoustics, an echo is the convolution of the original sound with a function representing the various objects that are reflecting it.
- In electrical engineering and other disciplines, the output of a (stationary, or time- or space-invariant) linear system is the convolution of the input with the system's response to an impulse.
- In physics, wherever there is a linear system with a "superposition" principle, a convolution operation makes an appearance.

Definition



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The convolution of f and g is written $f * g$. It is defined as the integral of the product of the two functions after one is reversed and shifted.

$$(f * g)(t) = \int f(\tau)g(t - \tau) d\tau$$

The integration range depends on the domain on which the functions are defined. In the case of a finite integration range, f and g are often considered to extend periodically in both directions, so that the term $g(t - \tau)$ does not imply a range violation. This use of periodic domains is sometimes called a **cyclic**, **circular** or **periodic convolution**. Of course, extension with zeros is also possible. Using zero-extended or infinite domains is sometimes called a **linear convolution**, especially in the discrete case below.

If X and Y are two independent random variables with probability densities f and g , respectively, then the probability density of the sum $X + Y$ is given by the convolution $f * g$.

For discrete functions, one can use a discrete version of the convolution. It is then given by

$$(f * g)(m) = \sum_n f(n)g(m - n)$$

When multiplying two polynomials, the coefficients of the product are given by the convolution of the original coefficient sequences, in this sense (using extension with zeros as mentioned above).

Generalizing the above cases, the convolution can be defined for any two integrable functions defined on a locally compact topological group. A different generalization is the convolution of distributions.

Properties

The various convolution operators all satisfy the following properties:

Commutativity:

$$f * g = g * f$$

Associativity:

$$f * (g * h) = (f * g) * h$$

Distributivity:

$$f * (g + h) = (f * g) + (f * h)$$

Associativity with scalar multiplication:

$$a(f * g) = (af) * g = f * (ag)$$

for any real (or complex) number a .

Derivation rule:

$$\mathcal{D}(f * g) = \mathcal{D}f * g = f * \mathcal{D}g$$

where $\mathcal{D}f$ denotes the derivative of f or, in the discrete case, the difference operator $\mathcal{D}f(n) = f(n+1) - f(n)$.

Convolution theorem:

$$\mathcal{F}(f * g) = \sqrt{2\pi}(\mathcal{F}f) \cdot (\mathcal{F}g)$$

where $\mathcal{F}f$ denotes the [Fourier transform](#) of f . This theorem also holds for the [Laplace transform](#).

Convolutions on groups

If G is a suitable group endowed with a measure m (for instance, a [locally compact Hausdorff topological group](#) with the [Haar measure](#)) and if f and g are real or complex valued m -integrable functions of G , then we can define their convolution by

$$(f * g)(x) = \int_G f(y)g(xy^{-1}) dm(y)$$

In this case, it is also possible to give, for instance, a Convolution Theorem, however it is much more difficult to phrase and requires [representation theory](#) for these types of groups and the [Peter-Weyl theorem](#) of [Harmonic analysis](#). It is very difficult to do these calculations without more structure, and [Lie groups](#) turn out to be the setting in which these things are done.

See also

- [Deconvolution](#)

Categories: [Computer vision](#)

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